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[Please stand by for realtime captions.]

Greetings, this is our monthly series. Today, we have Dr. Howard Townsend from our science and technology office providing an overview of our National Ecosystem Modeling that we've been doing. I want to point out that we will have our next presentation next month on June 13, at that point, we will be able to speak in more detail about 10 for implementation plans. -- National Marine Fisheries Service implementation plans. That will be on the second Wednesday of the month, June 13, same time and same place and same details. Thanks to the NOAA library, for hosting the series, it has been wonderful to advance our ecosystem-based activities. With that, I will ask Howard to come up, there will be an opportunity to ask questions later, through the chat box, correct Judith Salter?

You are welcome to put the questions into the panel, they will be recorded that way we will not miss any. C thank you Howard, thank you for coming.

[Cheers and applause]

Thank you everybody, a quick outline, to speak about what we've been up to in the last 10 or so years, nationwide with the National Ecosystem Modeling and talk about some regional efforts. If you have been watching the series, you will see some familiar slides that I borrowed from colleagues. We will talk a little bit about where we're going with this. But first, I want to clarify, if there are any oceanographers in the room, we're speaking of more than nitrogen-phytoplankton-zooplankton models, biological oceanography sense, we're really talking about a wide spectrum, this is a slide you've probably seen before of modeling we do for living Marine resources. Ecosystem Modeling for Living Marine Resources. On the right-hand side are models that are common to stock assessment. On the left-hand side, you can see the approaches of the multi-species and models up to the whole system, and to end models like the Atlantis software. --

That is what we will be talking about. Ecosystem Modelers, we use this slide a lot, talking about the spectrum of modeling, a few years ago I was speaking with Rick Methot about stock assessment modeling and they have onion of models, which is interesting because if you cut that onion just right, it would look like the spectrum. We really are thinking of as spectrum from sought -- stock assessment to the whole ecosystem model here. I will focus on the multi-species interactions. Alright?

First, why are we even doing ecosystem modeling? What is the main reason? For any model, you want to make clear connections, you want to make things explicit and clear and very objective. So you put it in mathematical terms. Especially when you want to tie into things for stock assessment, for protected resources, for habitat, and make it quantifiable and clear. Some of the key things that we are trying to do with ecosystem modeling is, can you still hear me if I do this? Okay. Use them for management strategy evaluation. Use them as an operating model. You can't really do ecosystem-level experiments with the real world, but if you have a whole system model, you can test out different strategies. For example, you can use a whole ecosystem to understand -- a strategy for one single species approach that might affect other stocks. Also Ecosystem Models can be used for doing skill assessment. Other disciplines use a wide range of models, like the weather service does for predicting hurricanes, they don't just use one model, they use multiple models with different structures. These models are good for trade-off analysis. If you fish one species what does that do the other stocks, to protected resources, to habitats and that sort of thing.

To date, the primary efforts, to coordinate across our science centers has been through our National Ecosystem Modeling workshops, and it has really been an opportunity, Like the National Stock Assessment Workshop, to bring modellers together, to swap code and good ideas and that sort of thing. But also to establish some standards and best practices for using these models in resource management. To get the high points of -- let me get back here. Since 2007, I knew it was over 10 years ago. The first workshop was really just our first opportunity to get together. It was in Santa Cruz California. We looked at the different software/code bases we had been using, We used is an opportunity to discuss model use and data requirements and those sorts of things - which model would work better and which circumstance, which application and also laying out some groundwork for what are the best practices. That way the models could be more readily taken into for management cycles.

The second one we had, which was in 2010, I think it was, was just down the road here in Annapolis, and it was focused on uncertainty. We had a sense that one of the reasons the models were not being used more, was because there was a lot of uncertainty associated with them and applying them to Living Marine Resource Management. So we took some time to break down the uncertainty, this slide depicts the adaptive management cycle and some of the things going on in the system that bring about uncertainty. With that, there is natural variability, and when we sample to build a model or do an assessment, there is observation error involved. With any model you use, you will have some uncertainty, if you oversimplify it or if you don't simplify it enough, in some cases, or even if there are miscommunications. How do you explain the more complicated models with lots of species? The top half here is scientific side of uncertainty, the bottom half is sort of the management side and how to communicate to the managers, how to get them to be specific about what they want the model to help them understand. Ultimately, there is outcome uncertainty, you can set something into place, the regulations, but how well does it get carried out? So you have to keep going through this cycle

to work through all these details. This great big uncertainty around these models, to break it down a little bit, and talk about how the models can address the difficulties of uncertainty,

We had the third modelling workshop. We wanted explore multi-model approaches, so multiple models. If you have a biomass as opposed to a multi-species age structured model, etc. up to ecosystem models, they all tell you slightly different things because they are picking up different details from the data, and what is going on in the system. This was a great opportunity, we talked to a lot of folks at the Weather service (National Oceanic Atmospheric Administration), oceanographers, climate folks to getting their insights on how they've used multiple models for their work. One of the interesting things that we learned from that group, was that at the end of the day, at the National Hurricane Center, there is still somebody that has to look - no matter how many ensembles you want to put together - you are not just going to look at one model or a group of models and say this is what will do -- will happen next. You still have to look at several, and then explain why you think the model suggests this. Another cool thing that came, out of this, as we talked about communicating and dealing with uncertainty. Using the qualitative network models, if you were here for Chris Kelble's talk last month, he talked about that and it is an idea that has really spread. I will talk more about that.

Finally, the fourth, what is the big strength? There are trade-offs, you can click multiple species, and understand how the management action or anything that people are doing to influence the ecosystem will affect focal groups and so, working on summarizing that as best practices and how to communicate those. Think about a really complex model with a lot of different groups from zooplankton to fish, whales, various fish feed, I can be very complicated, so how can we visualize that at the big Ness level. Some of the major recommendations from the National Ecosystem Modeling, we had not many groups doing active modeling, we wanted to make sure that it was supported throughout the centers. We wanted to adopt some standards and how to review the models, for example they go through stock assessment review process and then making management decisions with confidence. How do we do that with more complicated ecosystem models?

A few other big things that we pushed forward with, is making sure that each center has multiple models that it can use, either as an ensemble or multi-model approach, for different problems that are being solved. With these sorts of models, you have to do like you do when you are boating, do it early and often. [Laughter]

Some major outcomes, we had three of our centers have formal model reviews, so we should thank the folks here in Silver Spring because we have really seen the centers develop -- develop more modeling components and have opportunities to develop collaborations. I will go more into that in a little bit.

As we move forward, what are our goals for coordinating this? You want to make sure that the models are used to guide science to understand the ecosystems and ecosystem-based fisheries management . We want to make sure they are being used to explore trade-offs, the

more and more we've talked to stakeholders about it, we make a trade-off when we make a fishery decision. You fish a lot of one stock and it is eaten by an not -- a lot of another stock, you are making some trade-offs, we will discuss that. We will look at that as such a management strategy.

Ultimately, we want to make sure that this is incorporated into management advice. Moving towards pushing ecosystem level reference points, in addition to your singles species, that you have reference points. For example, Alaska has -- there is a much broader range to test out. [Inaudible- static]

Again, making points here we want to make sure that all centers have capacity to respond to questions that come up with fishery councils, or protected resource actions, that we have the capacity for developing these models and applying them. Most centers have developed quite a few, we are pushing more towards the application part of things. We also want to make sure that the regional management is using these. That they can understand the models and incorporate them properly into their management.

Some of the priorities now for this are, keeping track of what the centers are doing and it is amazing what they have done. If you have been following the series, you have seen the array of work that has been going on. Also, reviewing these models throughout the applications, developing some systematic standards for these models, to make sure that they are reasonable, being applied well, using the best data available, and those sorts of things. Finally, we are working towards a development of a toolbox, we are working with those groups to incorporate the ecosystem into the toolbox. The idea there, is if you have some standard set of tours, it makes review easier and uptake into management a lot easier.. That way they are familiar and have been tested. C now, moving on to the regions, all the different bodies that are science centers and deal with on a regular basis. Each of these have different sets of issues, that is another reason to really get the ecosystem moving forward and make it more operational.

And then we are going to touch on Alaska. Alaska has quite a range, everything from ocean circulation models, to nitrogen plankton models, as a base for information on food and fish stops, all the way through their feast model, if you saw Kim Ivins talk on this, a very complex and to end modeling approach. There were things in between, the quandary of networks, multiple regions, they have really been at this for a long time and have quite an array of models going. They were having some measurable success in getting this model incorporated into management advice. This is just a blurb from one of their scientific and statistical committees, it was common on public stock assessment -- Polak stock assessment. To be able to figure out that, it is an old statement now, but they were concerned about [Inaudible] maybe we need to do a more cautionary approach, setting our limits and that sort of thing. Again, just to point out, if you were here for Karen's talk a few months ago, the baseline project, this is really incorporating a lot of those best practices. They are using multiple models, everything from their eco-path model to the single species model to the left, all the way to the end to end, chemistry, up to socioeconomics with their feast model. They are looking at multiple scenarios, future scenarios

on climate, fishing, and doing management strategy evaluations. They have really adopted a lot of the best practices, moving forward, and working with their councils to do this sort of thing.

Than the Northeast, that is another's one of our centers that has a wide range of models, everything from the top where it is simpler or multi-species, biomass type models, network models down to fairly complex into an type ecosystem models. Lot of the network models are simple, they are not simple but you can make them quite complex, they just typically require less data. We have quite of a number of models to choose from depending on what types of issues arise in the region. They have been using this, -- these. And then how do we structure our information load so that we can understand the system, apply it in sort of a management strategy evaluation and use that to understand what the key interactions and risks associated are. What are the trade-offs as well? What does it do for interconnected species? So, again, they've really done a great job moving forward with applying these sorts of models. If you are around for [Indiscernible name] talks, Isaac, he had a ton of different models that he talked about, but one that really struck me was, again, on the California part where they were using three different models, Eagle Pass, model of intermediate complexity, to look at pollock. Getting complex information like this, to point out that it was having an impact on ground pelicans and depending on how much biomass was being harvested. Another thing that they have done, and the Northwest Center is in a great -- integrate their ecosystem in the integrated system group, you have to be careful using that, and how several of these steps allude to using the models. Using models that synthesize available data, I did not highlight that enough at the beginning. With these systems, you get pretty good data sets, a broad range of data sets, you have to reach out to multiple groups, we do our own surveys within NEMoWs . Just to build a model, that is sort of a hanker for your data sets, and understanding how much you can quantify and help thing to guide the thinking and where to look for information, that is very useful to share with stakeholders as well.

Also, using models to understand how different stressors at different levels in the ecosystem will affect the system as a whole. Moving now to a more formal analysis of management strategy, there really has been a lot of moving towards ecosystem steps.

And then, in the southeast, this is an interesting example that you may not have heard of yet, it is not so much our center doing the modeling, but it is colleagues in the South East regional offices, understanding all of it, it has been an interesting case. In the Southeast region, coastal Louisiana, they have lost a lot of [Inaudible] over the years, so there are several plans on the table to create freshwater divergence, to rebuild the sediment.. The office of habitat has to make decisions on that and consult with the Army Corps of Engineers, and understand how it will affect fish stocks. So, there are several federal agencies, I will not go into all of the details on who is working on this, the environmental impact statement on this, but using these models help to guide the thinking. This is probably their second round, they have looked at some other diversions, multiple others, but using two models, looking at how freshwater affects species, the increase in March how it would likely affect the product hippity of the system. Again, our focus of this has been the Magnuson-Stevens Fishery Conservation , and also the Marine Mammal

Protection Act , colleagues from multiple centers have been using ecosystem models to evaluate different control rooms that have different control rules. To look at these frontiers, to understand, as you increase tax, what does that do to the biomass etc.? Harvest control rules and such. That is not quite made it to management yet but that is what is very useful, the sort of thing that strategically we should be exploring, for harvest control rules.

So, where we going with all of this? We have made a lot of progress over the years, a lot of cool things with models, a lot of great work. I think a Graw -- a lot of the places we want to move towards, we want to make sure the modeling as well connected to the ecosystem approach. A lot of us are plugged into fisheries and well connected, that is a good process for the stakeholder, and for incorporating more social economic components. That is one of the things I probably did not highlight enough. It is hard to tell which is more valuable. I will speak of my experience just working at Chesapeake Bay, the ecosystem model that I was running, to explain to people that trade-offs, management would say, when I am walking down the hall talking to the State Senator, how do I explained to that person, which is more valuable a pound of bass or a pound of another fish. He was talking about integrating more social economic areas. That is a good place for us to plug in more.

Also getting more involved with the evaluations. Management strategy evaluation, to expand those two ecosystems so that you can also do more trade-off analysis. Also, working on more standardized tools. A lot of these models start off with code, we pull together some ideas, and then building some great models, we want to make sure those models do get shared and get standardized so that other stakeholders can take them up. Visualization is important as well, you've seen some messy and busy crafts, but finally, again, is much as we are moving towards the quantity of trade-off applications, and more ecosystem reference points. Just mentioning the EBFM , what we have done in these big areas, that the set of diversion, that group now is developing quantitative network models, to understand more of the social economic components and have it be more Inc. This is an example. There are lots of room -- there is lots of room to incorporate more. This is a strategy evaluation that talked a little bit about [Indiscernible name] and this is the sort of thing that can be done across the board, especially engaging stakeholders, this quantitative network is one of the first steps to know what the first strategies to apply it would be.

Develop your toolbox, in the past year and a half or so, we have taken some of the more commonly used models. Some are ready have their code base, Atlantis, but there are others that are more statistical assessment models, such as multi-species, surplus production, age models, counterparts, single species world, we are looking to get one of those built into a toolbox and that sort of thing that would make it easier to use. Again, this is highlighted in the roadmap but is sort of a quake glimpse. We have a nice graph here to help you see the data and explore scenarios, by tweaking the numbers, see what it does to different species. Maybe some other time we will do a more interactive toolbox talk. If you have standardized code based that has been reviewed, it does take -- make it easier for folks to learn this. If somebody doesn't want to go through an in-depth C++ program, but they understand the system and nowhere to

get the data to plug it in, and know how to understand, our niche colleagues, we also get international fisheries in academia as well. They like to take up some of these toolbox approaches. For example, the fishery commission has worked on an earlier version of our population analysis, they said that they would work with them to start using the you -- the newer version.? That is the sort of thing, you produce a model, and then people get proud of that model, but you want to try and make it more simple. This one is a little too simple, from the Alaska Center. You can understand the connections.. [Laughter] plenty of people will get into the weeds with this, the four education, outreach, and explaining to broader stakeholders, these are particularly good tools. They are good ways to visualize, even if you think of fisheries management councils, going through a week of making decisions, and they have five or six different stocks, for each of their stocks they have 150 page report that they are supposed to read through and make decisions. It is not very good for uptake, you show them something like this, and it does slow down uptake. This virtual ecosystems and area, -- scenario is great to explore in an interactive way what is going on underwater, in different scenarios. This is one example of several visualization tools that we have, that can be helpful in improving the uptake.

Last but not least, a few things on stakeholder engagement, all policy and all the statements in the things we have written about, this is probably the core of it. I'm not asking you to read it but I will recap the statement. The basic idea is, you have to make decisions about resources in the ecosystem, about habitats, protected species, you have to make decisions even if you use an imperfect model, that is probably better than multiple stakeholders who have their own mental model of the system. Then they are making their assumptions, and their estimates about what is going on in the system. At least have an imperfect model that everyone is looking at, you can then argue the finer points of that model, instead of having 20 different stakeholders with 20 different ideas on how the system is working. The idea here is, you don't want somebody who believes nothing about the model, you don't want somebody who is a true believer and believes everything with the colored lenses, you want to be able to use the models and Inc. about them and their efficiencies -- and think about them and their efficiencies in a realistic way. I am trying to leave a little bit of time for questions or comments..

We will open it up to folks in the room here first. And then we will look at the questions online.

Sounds good..

I have a quick question about model performance and back to our survey, I do not know much about this model, but the survey mechanism, building apps, for performance as a benchmark to [Indiscernible name] [Indiscernible -too far from mic]

One of our, actually probably a couple of our data inefficiencies were listed. Input parameters and then for timeseries that we tune the model to. We find things like we don't have a lot of base homes for plankton, so maybe it would be helpful if they are doing crazy things that might alter the stability of the ecosystem, so, it is certainly assuming that we could reduce uncertainty here or there, then that helps with the model.

We will go to the chat box now. West Coast office, it looks like you are exploring lots of different models, but not on the SQL -- [Indiscernible -too far from mic] why are you pushing to use your reference points to find out what measures they are interested in using?

Take the pushing back, I don't mean that I am pushing, the reference points is an important thing to be considering so that we can understand if actions are altering the structure and ultimately the long-term productivity of the system. I probably should not have said pushing, but certainly we do not have a lot of it and it would be a useful indicator. We are trying to work more closely with the management, to see what they would like, it is a difficult conversation. I will say I have been working with the National Marine Fisheries Service commission for at least 12 years now, and sometimes there are not models that really answer all the questions, but it is a slow process, we just need to understand what the models can do so that they know how to frame the questions. The model lists need to understand as well. So instead of saying pushing, maybe more on the stakeholder engagement side, I hope that was a good enough answer, we will definitely talk a little bit more later. May be we should write a paper about that.

You are showing the spectrum from several species models, the socioeconomic, are there constraints on how complex these models can get? Is that type of model [Indiscernible -too far from mic]

That is a good question, Jay was just asking on the spectrum of models, the high-end complex and, things like Atlantis or feast or those sorts of models, go from high dynamics to food webs to fisheries and socioeconomics, is there a limit to how far you can go? There are all sorts of limits, for example, the feast model, you have to get through high-performance computing, servers to run that. Is really the only limit, I think.. There's also a limit to engagement processes. One of the key things to care about, and focus on, you can throw in a model that ultimately, everything on earth is interconnected, but you are getting kind of way out there, so those types of models are getting as complicated as you would likely get. I don't know. What will happen in 10 or 20 years, down the road, that seems to be as complicated as people will get for a wild.

There are a couple of other questions coming in. References to documents, in the library --

Look at that, all kinds of great services.

Isaac is on the line. Do you have any advice for ecosystem models and computing intensive, what are your directives against ecosystem modeling?? Yes, thank you, Isaac. [Laughter] I've been getting a lot of questions and discussions on that, Mike and I just had a talk on this a few hours ago, within the NOAA computing program, there is a fairly small case, we have used that around the different centers. We sort of test things out, incubator type projects, and how they have their server set up is always suitable for super models. They are set up for highly paralyzed, I cannot believe I said that out loud, there is a lot of processing power. Some of our models, do not need so much processing power, because they are not set up to run parallel, like

Atlantis, we need different configurations so we are getting to a point where we are starting to have those discussions. Last week, I was talking to the fisheries information division, about if there are some cloud computing options that we can stumble upon. I do not have a clear answer other than, we are exploring those types of things and I would love to get your input and suggestions on what you think would work best. Thanks, Isaac.

[Indiscernible -too far from mic]

I just got a recap, no I was just asking about this last flight, some of the stakeholders are pure skeptics, and that is probably one of the reasons it is not getting taken into management. Also suggesting more of the economic concerns, bringing stakeholders. That's why I keep hitting on the stakeholder engagement part, it seems to be working well, the quantitative measures. That is a trick we have learned 10 or 15 years ago, this is what I have data for, this is what I'm going to start putting together. And now, with more of these quantitative network models, let's not worry about the data yet, let's understand the key concerns for stakeholders, get those not doubt and a rough estimate of how strong Dr. asked -- factor X a fax factor Y -- fax fax -- affects Dr. Y.

There are some pretty detailed questions that we will just send to you. What recommendation do you have for getting managers to understand and appropriate use the models?

What recommendations do I have to get managers to use the models and that their decision-making? When you vote, you want to engage stakeholders early on, that is one of the key things we have said at every single NEMoWs meeting. I know that everyone is busy, and it takes several passes, I will just use the analogy that I have used in the past, lots of times we do modeling and management, kind of like when you go to McDonald's, somebody steps up and says they want a big Mac, a few minutes later, there is something wrapped up, presumably a big Mac, if you don't open it up and walk away, it might be too late. Let's go ahead and move away from that approach and go with the subway approach, you specifically design and have the interaction as the model is being built. That is why I love this and analogy, we have used it a lot and talked about it a lot. We are moving in that direction a lot with those system models. That is the biggest thing, understanding specific objectives that the managers have, at the end of the day, what does the mandate tell them that they have to decide on, what level information to they need? Cracking that not but still chipping away at it.

Any other questions in the room? We have one more online. This is from Bill. He is interested in the Louisiana study you mentioned earlier, with the habitat change, [Indiscernible -too far from mic] interested in the Caribbean version -- [Indiscernible -too far from mic]

Yes, so, Phil was asking about the shoreline stop and let's make sure I have this right, you saw that as I habitat change and how it influenced the resources. So, that can be applied, certainly, there are lots of ecosystem modeling approaches that connect habitat to fisheries, to living Marine resources and that coastal Louisiana example was solidity, temperature, and actually

shoreline surface, marsh edge. We had quantitative, responses in some cases, of the living resources to the habitat. So we were able to map out, grabbed out, sort of preferred temperatures for different species and how that might affect their feeding, or reproduction, ultimately its conception. That sort of approach could be used, other times you might have things requiring a lot of data. You really want to sit down with a group of modelers and say, here are the questions we are asking, this is what we think is important, this is the data we have, and then work with that group to see what the model would be that would be best suited to answer the question given your circumstance. Bill, we should talk about getting back into models together. Down in Puerto Rico or something, or in the Caribbean somewhere. [Laughter]

I think that concludes the questions, again, thank you Dr. Howard Townsend .. If there are additional questions, Howard is willing to answer any questions, just email him. A reminder, June 13, we will have a presentation on the status of [Indiscernible name] being developed by our regional science centers. We look forward to everyone joining us then. Thank you.? [Applause]

[Event Concluded]
